Estimating the Rate of Technology Adoption for Cockpit Weather Information Systems

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Overview

- Presentation will cover:
  - Background of Study
  - Brief Description of Survey
  - Characteristics of the Successful Cockpit Weather Information System
  - Business Case of Cockpit Weather Information Systems
  - Adoption Rate Estimate

Background of Study

- In 1997, Clinton establishes a national goal to reduce fatal accident rate by 80% in ten years.
  - Weather is a factor in 33% of commercial and 27% of GA accidents.
  - Aviation Weather Information (AWIN) project was created with the goal of developing the technologies that will provide accurate, timely, and intuitive weather information.

AWIN Focus

- Elements of AWIN efforts:
  - Understanding user-centered requirements for weather products, systems, and components.
  - Assess impact of existing and under-development weather information technologies and concepts on achievement of national goal.
  - This study is a component of these AWIN efforts.

Research Questions

- This study examined three questions:
  - What are the general product characteristics of the cockpit weather systems that eventually will achieve success in the target markets?
  - What is the financial motivation (business case) for adoption of advanced cockpit weather systems by these market segments?
  - How quickly will the market segments adopt cockpit weather systems?

Survey Overview

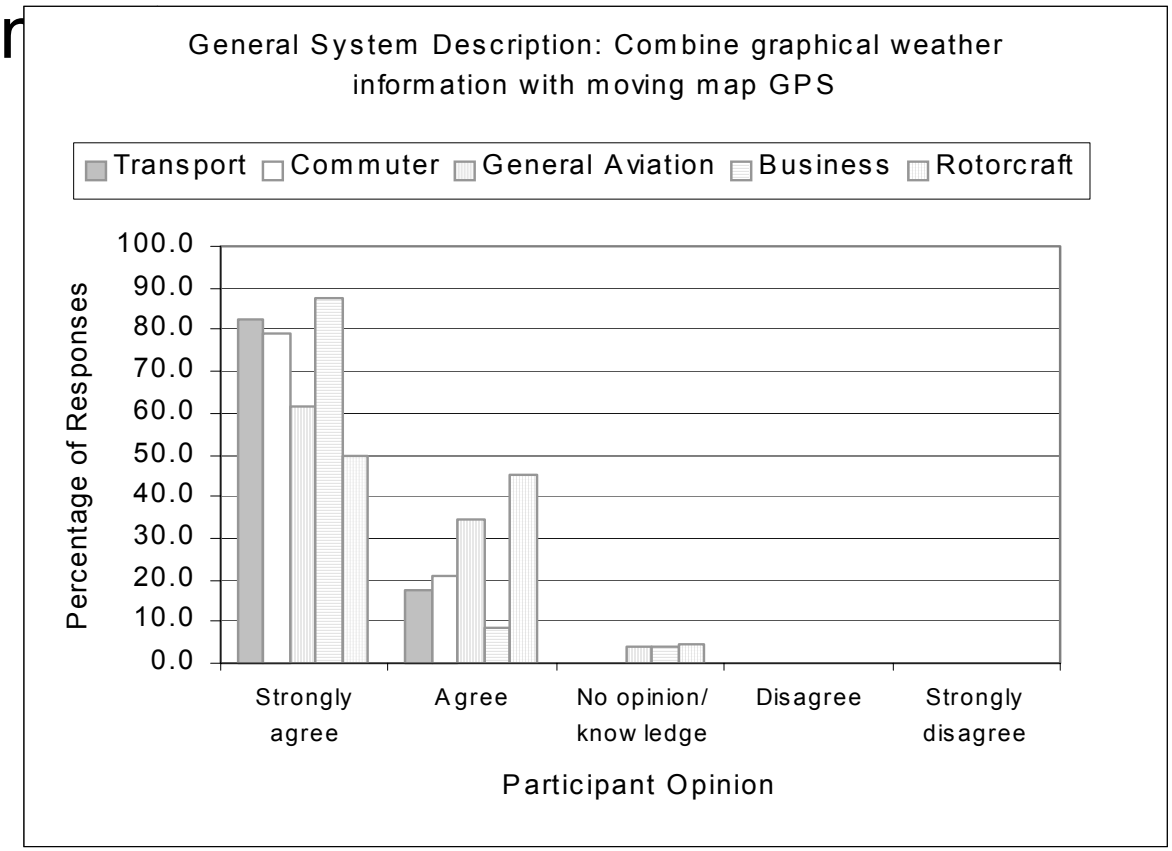
- Survey targeted five industry segments:
  - Transport, commuter, general aviation, business, and rotorcraft.
  - The survey contained 27 questions and included the opportunity for open-ended comments from participants.
  - Distributed to 60 organizations selected to represent the primary groups involved in the aviation market. 32 were returned and typical question had 20 or more responses.

Characteristics of Successful System

- The first group of survey questions asked participants to describe the characteristics of the cockpit weather information system they believed would achieve commercial success in the five market segments.
- This established a system base line for the business case and the adoption rate questions to follow.

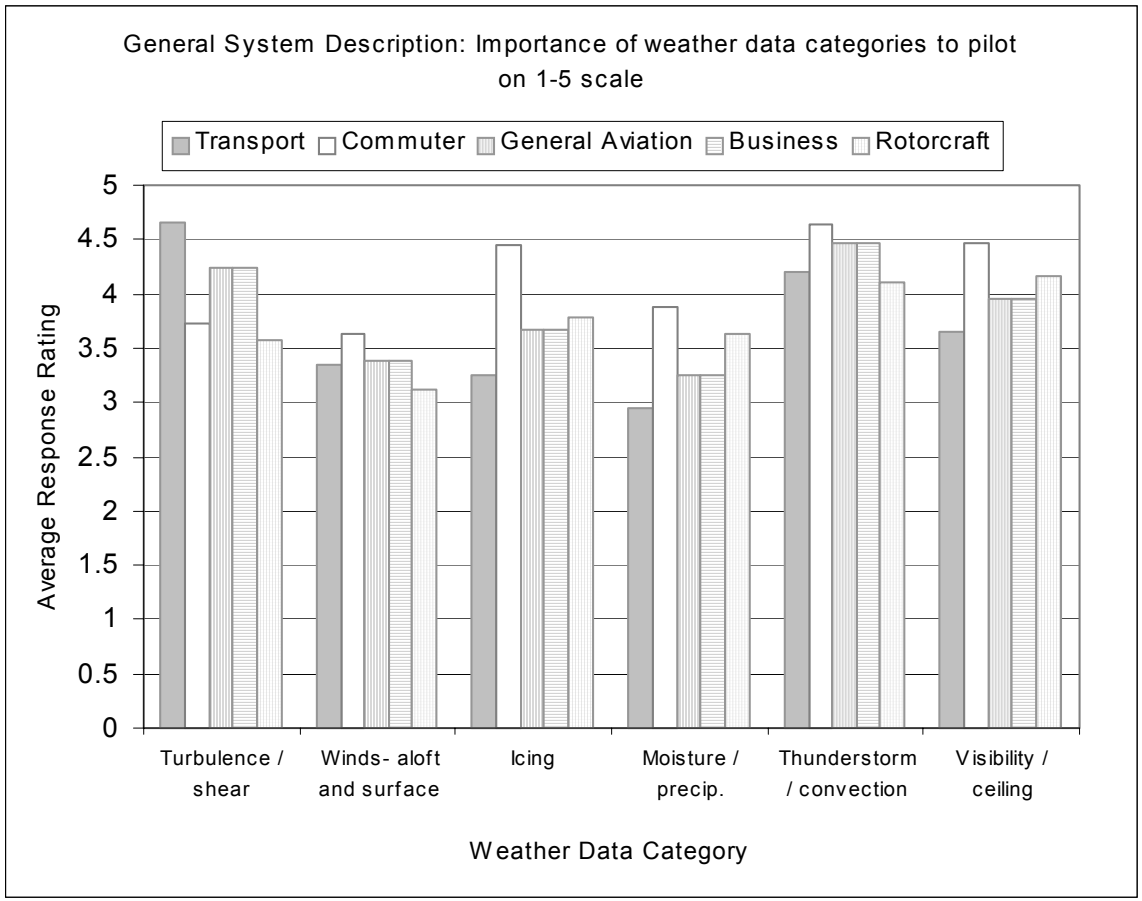
System Characteristics Overview

- Over 90% of participants believe that the combination of moving map and GPS is a product success factor for all market segr



Importance of Weather Types

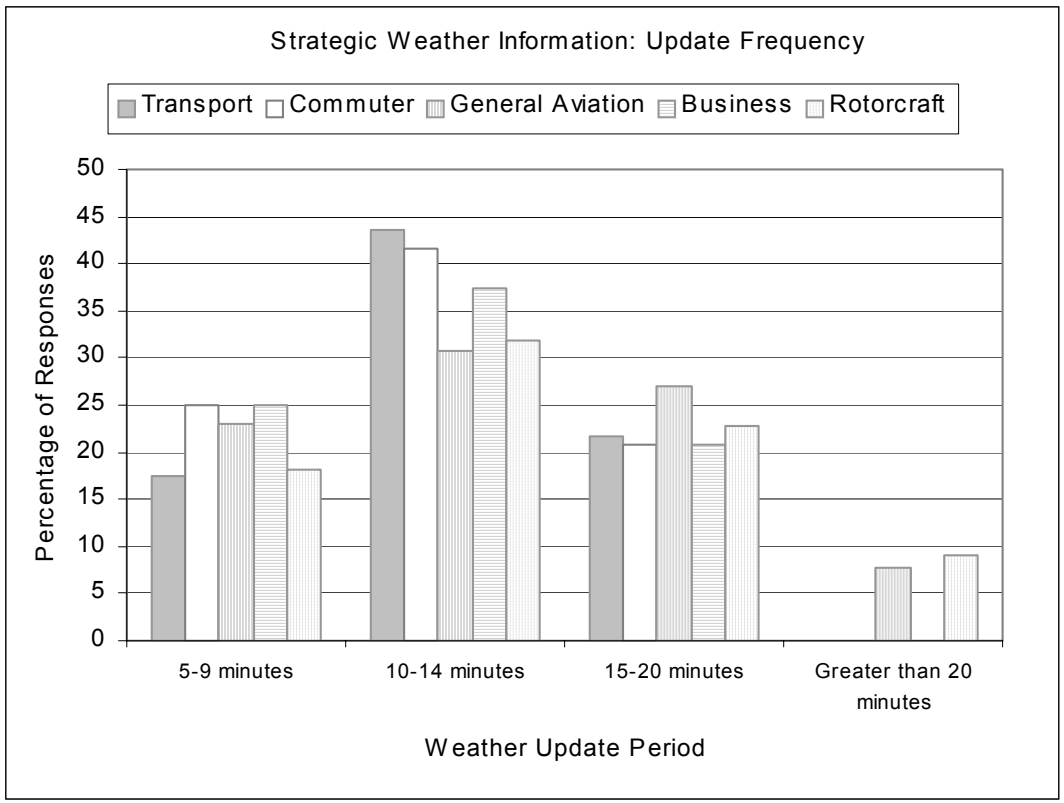
- Participants rated the importance of types of weather information:



Winds and moisture/ precipitation are less important.

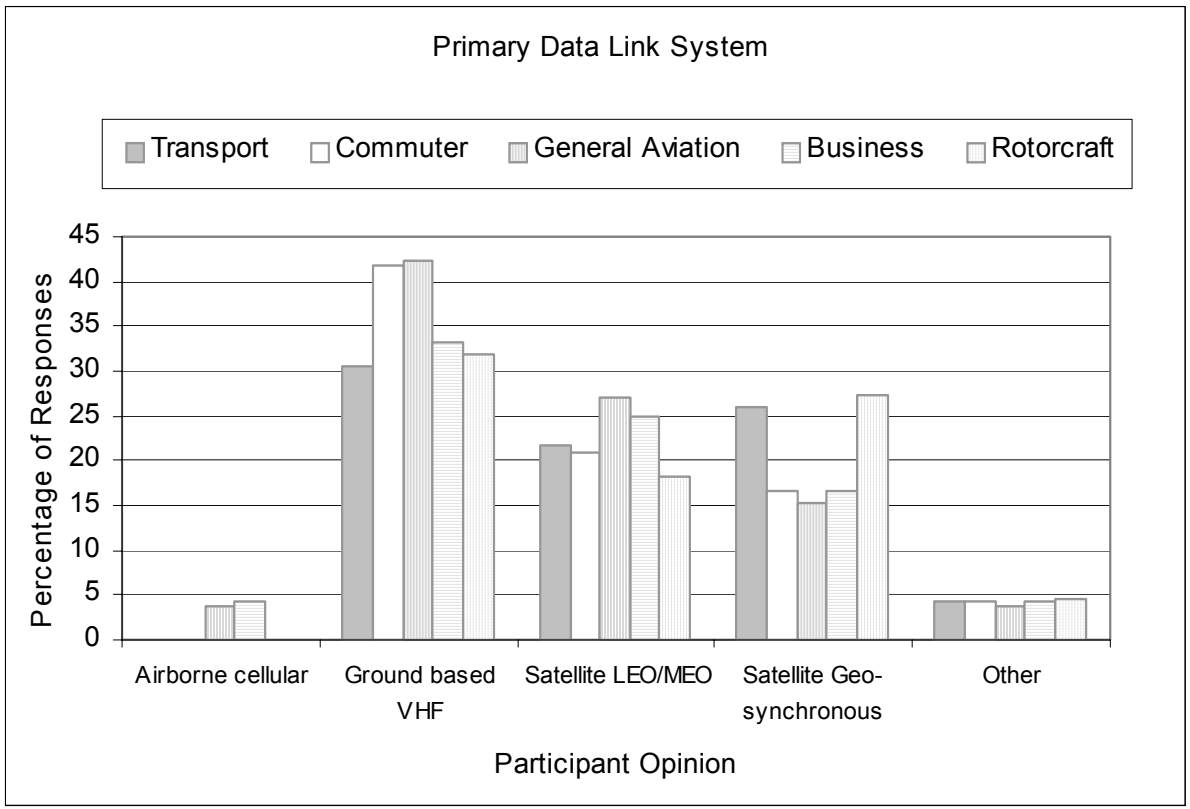
Information Update Frequency

- Largest proportions in all segments believe a 10-14 minute update interval is adequate:



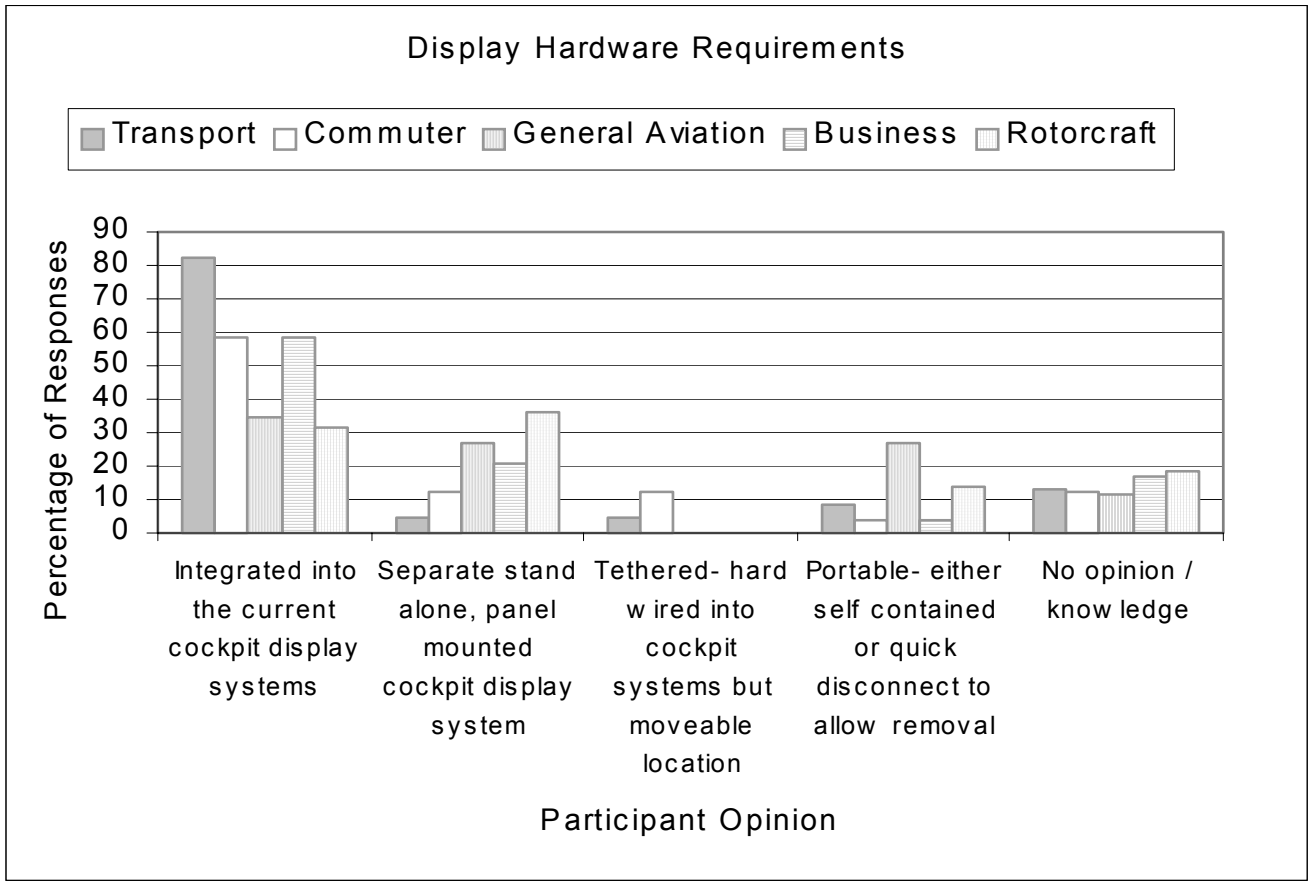
Data Link System

- More participants believe a satellite system will be the data link.



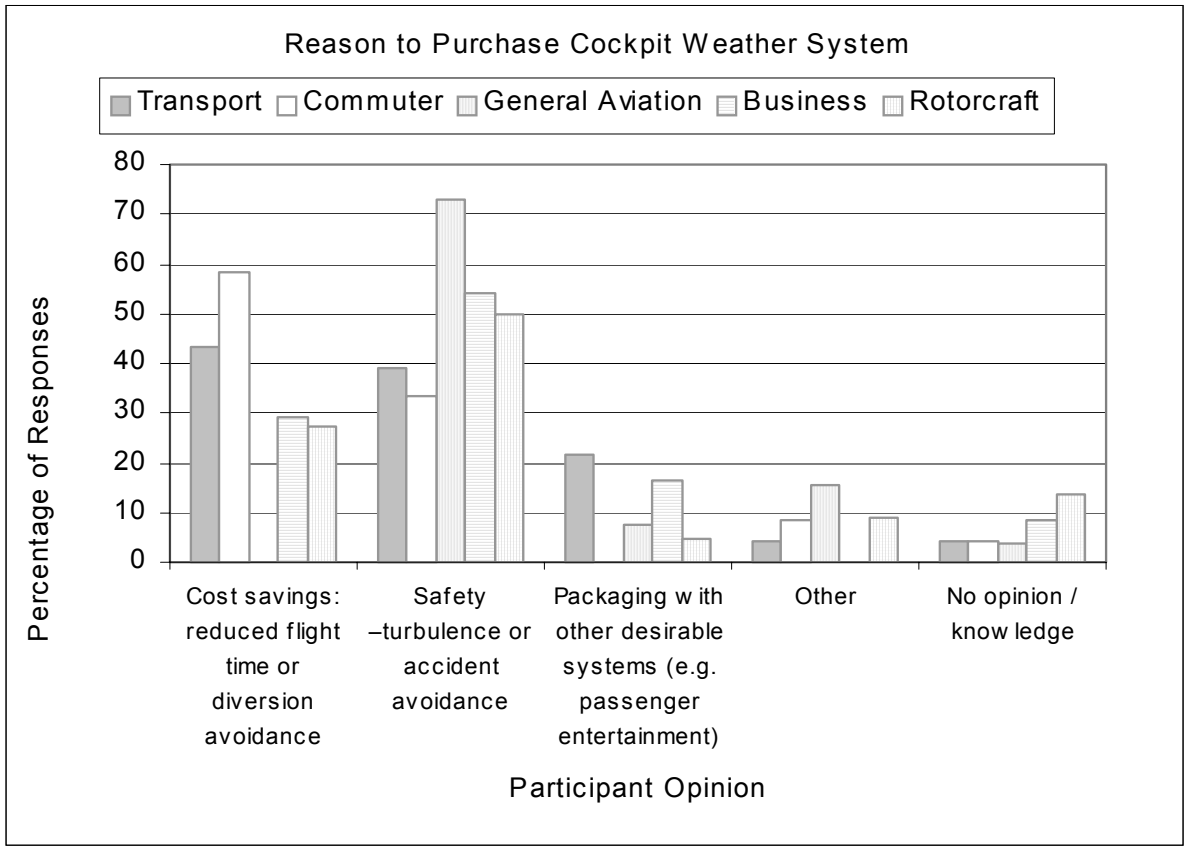
Display Hardware System

- Most participants believe the display will be integrated into the current display system



Primary Reason to Purchase

- The primary reason to purchase varied by market segment:



Business Case

The survey asked a series of questions to identify the business case for cockpit weather systems:

- Recurring annual cost for the weather information and transmission to the cockpit.
- Non recurring cost of the data transmission/link hardware that must be installed on the aircraft.
- Non recurring cost of the display hardware that will be required by the weather information system.
- Projected annual savings from diversion avoidance.
- Minutes per month of flying time that will be saved by use of cockpit weather systems to select routes that will be more time efficient.
- Operating cost for a minute of flying time in the five market segments.

The NPV / IRR Equation

- NPV (cockpit weather system) = - Expected value (Non Recurring Costs) - PV [Expected value (Recurring Costs)] + PV [Expected value (Recurring Savings)]
  - Expected values calculated from intervals on survey questions.
  - MARR= 12%, 5 year life

Example Responses

- Annual cost of weather information and transmission to aircraft:

Question 11: Recurring Annual Cost of Weather Information / Transmission ($)					
	Transport	Commuter	GA	Business	Rotorcraft
Expected value	5197	2045	433	1976	553
Standard deviation	4024	1840	316	1483	361
CV	0.774	0.899	0.729	0.750	0.653

- Estimated cost of hardware (non recurring):

Question 13:Non Recurring Cost of Display Hardware ($)					
	Transport	Commuter	GA	Business	Rotorcraft
Expected value	35833	16310	3792	18452	4833
Standard deviation	13504	10235	2629	9601	3125
CV	0.377	0.628	0.693	0.520	0.647

Question 12: Non Recurring Cost of Data Transmission / Link Hardware ($)					
	Transport	Commuter	GA	Business	Rotorcraft
Expected value	31579	12727	2100	15000	2789
Standard deviation	22672	8125	1275	9759	1575
CV	0.718	0.638	0.607	0.651	0.565

Examples of Savings Estimates

- Responses on Savings questions:

Question 15: Annual Savings from Diversion Avoidance ($/ yr.)					
	Transport	Commuter	GA	Business	Rotorcraft
Expected value	75000	25000	1000	17308	2083
Standard deviation	35843	12649	1000	8321	2285
CV	0.478	0.506	1.000	0.481	1.097

Question 16: Minutes per Month of Flight Time Savings (min. / mo.)					
	Transport	Commuter	GA	Business	Rotorcraft
Expected value	56	47	27	47	30
Standard deviation	36	33	19	30	20
CV	0.647	0.707	0.723	0.639	0.679

Question 17: Cost of a Minute of Flight Time ($/min.)					
	Transport	Commuter	GA	Business	Rotorcraft
Expected value	74	33	2	33	5
Standard deviation	36	17	2	15	2
CV	0.484	0.533	0.686	0.450	0.447

Business Case Summary

- There is a compelling case for cockpit weather information systems in three market segments:

Market	Expected Non Recurring Cost	Net Expected Recurring Annual Cash Flow	NPV	Non Discounted Payback Period (years)	IRR
Transport	-67412	112448	337024	0.60	165%
Commuter	-29037	38501	109750	0.75	131%
General Aviation	-5892	753	-3178	NA	-13%
Business	-33452	30268	75655	1.11	86%
Rotorcraft	-7623	2736	2241	2.79	23%

Sensitivity Analysis

- Decision reversal tables examined the sensitivity of the base business case to one factor at a time:

Decision Reversal Table	Transport Market Segment		
Cost Description and Related Survey Question	Expected Value from Survey	Value to Reverse Decision	Percent change
11. Recurring- weather/ transmission ($/ yr.)	5197	98500	1795%
12 + 13: Non recurring data link + display ($)	67412	306000	354%
Savings Description			
15. Diversion Cost Avoidance ($/ yr.)	75000	-18500	-125%
16. Minutes saved per year (min/yr.)	671	-600	-189%
17. Value per minute ($/min.)	74	-66	-190%

The transport market business case is insensitive to changes in the survey data!

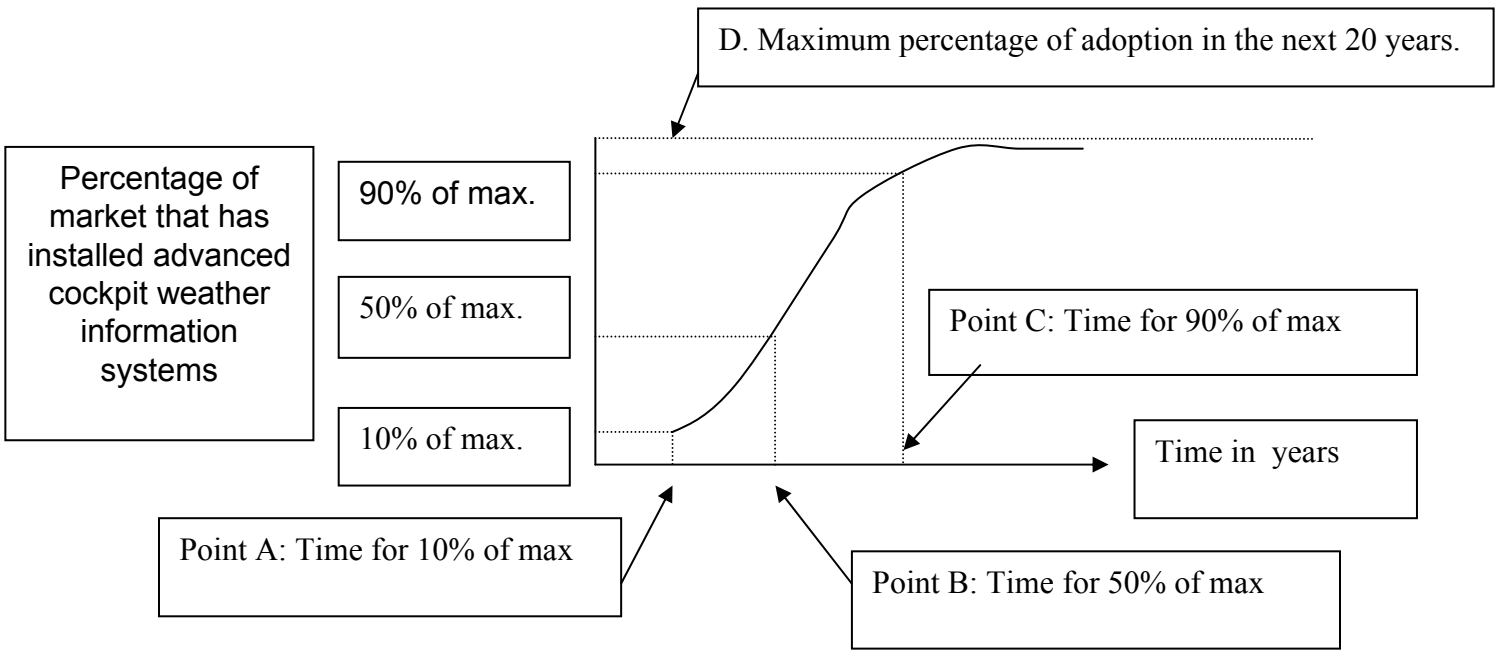
Monte Carlo Simulation

- Monte Carlo analysis examined simultaneous changes (1000 iterations):
  - Probability distributions were fitted to the survey responses.

	Transport	Commuter	General Aviation	Business	Rotorcraft
Mean NPV $ from 1000 Iterations	303828	98352	636	71884	-313
Standard Deviation of NPV $ from 1000 Iterations	49378	24515	3839	23130	3730
Percent 1000 Iterations Unfavorable (Negative NPV)	0%	0%	40%	0%	50%
Lower 95% Confidence Interval for Mean Present Value	300767	96832	398	70450	-544
Upper 95% Confidence Interval for Mean Present Value	306888	99871	874	73317	-82

Market Penetration

- The market penetration was estimated at three intervals:



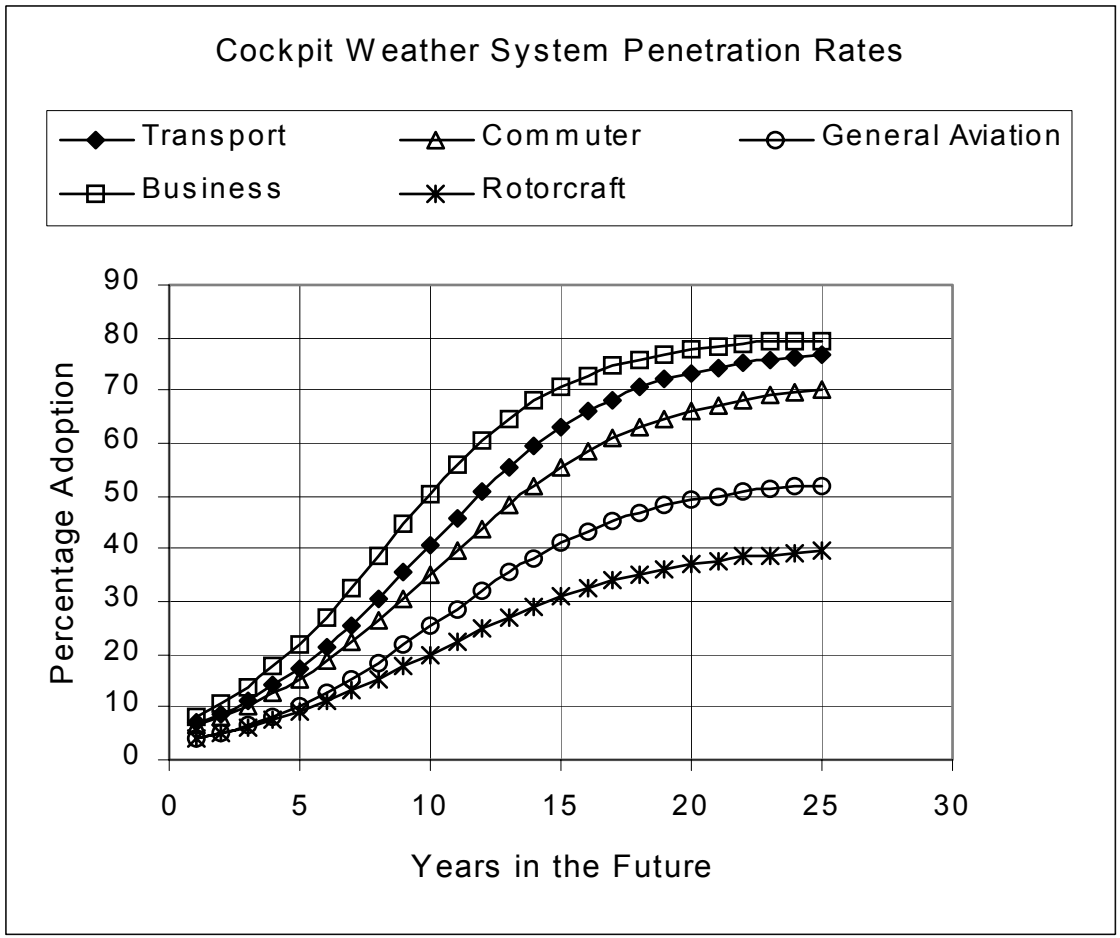
Point Estimates of Market Penetration

- Using the survey response, point estimates for the mean and confidence intervals were developed:

Market		Maximum Penetration (%)	Years Until 10% of Maximum	Years Until 50% of Maximum	Years Until 90% of Maximum
Transport	Upper 90% Estimate	86	5.0	10.3	18.9
	Sample Mean	79	4.0	9.1	16.4
	Lower 90 % Estimate	72	3.0	7.8	14.0
Commmuter	Upper 90% Estimate	79	6.0	12.1	17.7
	Sample Mean	73	4.6	10.1	15.4
	Lower 90 % Estimate	66	3.2	8.1	13.0
General Aviation	Upper 90% Estimate	62	5.4	11.9	16.9
	Sample Mean	54	4.5	10.3	15.0
	Lower 90 % Estimate	45	3.5	8.7	13.1
Business	Upper 90% Estimate	85	4.8	9.4	14.5
	Sample Mean	80	3.7	7.9	12.7
	Lower 90 % Estimate	74	2.7	6.3	10.8
Rotorcraft	Upper 90% Estimate	51	6.8	12.8	17.8
	Sample Mean	40	4.9	10.5	15.6
	Lower 90 % Estimate	29	3.0	8.3	13.4

Fisher- Pry Estimate

- The Fisher- Pry model provides an equation solution:



Conclusions- Cockpit Weather Information Systems

- Market adoption of cockpit weather systems should contribute to achieving national goals:
  - Product Definition: market segments agree on the basic product definition.
  - Business Case: There is a strong business case for potential lead adopters.
  - Adoption Rates: Even for early adopters, 50% of the market will require 8-9 years.

Additional Research

- The business case must be clearly defined.
  - This can be the strongest selling point and can increase the adoption rate.
- Work with the transport, commuter, and business segments should be initiated to substantiate the data in this survey.

Acknowledgements

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